PROTECTIVE IRRIGATION WORKS,

RAJPUTANA.

BUNDI STATE.

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REPORT

ON THE

HARIPURA PROJECT

ON THE

GHORA-PICHAR NULLAH,

NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION IN RAJPUTANA.

COMPLIMENTS

AJMER:
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1904.

INDEX.

BUNDI STATE.

HARIPURA PROJECT ON THE GHORA-PICHAR NULLAH.

Note by the Consulting Engineer for Irrigation in Rajputana.

I have carefully inspected the site with the Superintending Engineer (Mr. Manners Smith); and have gone over the Plans and Report he has submitted, and consider much credit is due to him and his staff for the way in which the Project has been prepared.

2. The Project appears to me to be a very good one. To be able to store 380 million c. ft. of water (which now all goes to waste annually) and to make it available for Irrigation every year, for an expenditure of Rs. 1,77,311 is worth consideration, especially in a country like Rajputana.

3. If the work is properly carried out, and due advantage taken of the water, it ought to bring in a return at about 5 per cent. on the outlay, and it might be the means of great benefit to the State and to the people.

The money would be all expended in the State, which therefore would lose nothing, while the annual gain in the water stored, ought to bring in a good return.

I strongly recommend the work.

JAIPUR:
29*th November* 1904.

S. S. JACOB, COLONEL,
Consulting Engineer for Irrigation in Rajputana.

REPORT.

Site defined

The many tributary Nullahs, which eventually join to form the Ghora-Pichar River, after uniting have cut their way through a natural ridge of high ground, which extends from the hills on the east of Kisanpura village on the right bank, to those on the left beyond Haripura, a distance of 3 miles.

This site is a good one for constructing an earthen Dam across the river, as although the Dam would be 2¾ miles long, except for the portion across the river, it would be only 10 ft. in height, as the ridge forms a natural Dam.

Line of Dam.

2. The Dam would start from the hills on the right bank, crossing a tributary Nullah—across which the Weir would be constructed—to Kisanpura village. Then crossing the river to Haripura the Dam would follow the ridge until the hills west of Laen (deserted village) are reached.

Catchment Area.

3. The Catchment Area is 135 square miles. Of this the water from 43 square miles all passes to the site, and the Nullahs which drain the remaining 92 square miles divide and flow partly into the Sukli River and partly into the Ghora-Pichar; but by means of Guide Dams, at the points of separation, as much of the water as is required can be diverted to the Haripura site. (See Index Map, Plan No. 1).

Water available for Storage.

4. This Catchment Area is all hard and rocky, so that a good run-off will be obtained; the storage basin is very large and is waste land, except for the villages of Retia and Dolpura, and their small areas of culturable land, about 500 bighas in each village, which will be submerged. The village of Laen, shown on the Index Map, which will also be submerged, has been deserted since the famine. There is plenty of good earth for constructing the Dam, and below the site the rich alluvial soil of the Bundi Plain is commanded.

Waterspread and Capacity

5. If we allow only 10 per cent. of the average rainfall of 21½" to be available for storage from the 135 square miles of catchment, we shall have 677 m. c. ft. of water at our disposal.

6. The following table gives the waterspread and capacity of the proposed Storage Reservoir at the different contours. R. L. 156 is bed of river at proposed site for the Dam :—

R. L.	Waterspread in s. ft.	Capacity in m. c.ft.
207	66,880,000	125·60
205	58,720,000	155 71
202	45,088,000	81 09
200	30,000,000	144·00
195	21,600,000	84·40
190	12,160,000	45·60
185	6,080,000	24·80
180	3,840,000	30·72
156 (bed level)		
	Total ...	691·92

Land and Water available for Irrigation.

7. The land to be irrigated is all on the left bank (see Index Map Plan No. 1), and about 13 square miles in all is commanded.

If we make our weir level R. L. 202, which nearly corresponds to the natural level of the ridge from Haripura westwards, the tank will have a capacity of 410·61 m. c. ft., and taking R. L. 180 as lowest sluice level we have 379·89 m. c. ft. of water available for irrigation, sufficient for 3,200 (see para. 11) acres, or say 5 square miles, which is less than half of the total area commanded on the left bank, but sufficient for our requirements at present, at any rate.

Weir.

8. The Weir will be on the right bank at the east end of the Dam, on a tributary nullah, by which the overflow will be carried down to the river again, about one mile below the Dam. The Weir will be 1,160 r. ft. in length, to discharge the maximum flood of 32,670 c. ft. per second (Dicken's Formula) on the 135 square miles of catchment, with a 4 feet head. It will be constructed of lime masonry, with foundations on rock, 2½ ft. thick at top, a front batter of 1 in 12, and the thickness at any point is $T = \frac{d}{\sqrt{g}}$; where d is the depth below flood level, and g the specific gravity of masonry, assumed to be 2·24.

As there is a ridge of ground forming the watershed between this tributary and the main Nullah, a Channel 1,160 ft. in width will have to be cut across this, parallel to the line of Dam, to give a free waterway to the Weir (see Contour Plan No. 2). The earth to be excavated for this Channel amounts to 47,63,500 c. ft., and this will practically all be used in the embankment between the Weir and left bank of main Nullah, for which 46,43,560 c. ft. are required. A tramway will be laid for the carriage of this earth, and an extra rate for this portion of the earthwork has been entered in the estimate.

Dam

9. The Dam will be of earthwork, with crest R.L. 210 (or 8 ft. above weir level, and 4 ft. above flood level), top width 10 ft., front slope 3 to 1, protected by pitching up to flood level, and rear slope 2 to 1.

From chainage 1,660–2,250, at the east end, and in continuation of the Weir, the Dam is provided with a core wall; and again from chainage 6,750–7,250 and from chainage 9,250–9,750, where the sluices will be constructed. The core-wall is of lime masonry 1½ ft. thick at top, and increasing 6″ at every 5 ft. depth by 3″ offsets on either side. The foundations will be carried down to rock, or hard soil, and will consist of a 5 ft. layer of concrete.

From chainage 5,250–6,000, where the Dam crosses the river, the top width is 20 ft., front slope of 4 to 1, pitched to flood level, and rear slope 3 to 1.

In this portion leakage may occur; to prevent this doing any harm dry stone pitching should be placed at the toe of rear slope, and between this and the sand, bajri, to keep the sand back but allow leakage to pass clear without bringing sand with it.

10. Two Sluices have been provided; Sluice No. 1 is at ch. 7,000, with sill at R L. 180; Sluice No. 2, at ch. 9,500, with sill at R. L. 190. The water available for irrigation between R. L. 202 (full supply) and R. L. 180 (lowest Sluice) is 379 8 m. c. ft. Sluices.

Sluice No. 2. (high level Sluice) commands $2\frac{1}{2}$ square miles or 1,600 acres, of which half, or 800 acres, may be taken as requiring irrigation, and this will require 80 m. c. ft. of water, leaving 300 m. c. ft. for Sluice No. 1.

There are wells near the villages, and water is raised from the river to irrigate land near the banks, but by far the greater portion of the land commanded is at present unirrigated and only cultivated for the rain crop.

11. Sluice No. 1 has therefore to discharge 300 m. c. ft. of water in four months (Rabi irrigation season) or $\frac{300 \text{ c. ft.}}{10{\cdot}368} = 29$ c. ft. per second continuous flow. Sluice No 1

Two Sluices of $1\frac{3}{4}$ ft. diameter can discharge this amount with 1 ft. head, and have been provided.

As the water from Sluice No. 1 has to be let down the river to the head works of Irrigation Channel No. 1 at Namano, a certain amount will be lost by absorption in transit.

It is impossible to say exactly what this will be, but even if we allow a loss of 20 per cent., a high rate, we shall have 240 m. c. ft. of water available for irrigation, sufficient for 2,400 acres.

To give this area a first watering of 6″ in 30 days of 12 hours, the Sluice will have to discharge $\frac{2{,}400 \times 43{,}560 \times \frac{1}{2}}{1{,}296{,}000} = 40{\cdot}3$ cusecs, or adding 20 per cent. for loss by evaporation in transit 48·3 cusecs; and this can easily be discharged, by the Sluices provided, during the first month, when the reservoir will be nearly full.

12. Sluice No. 2 has to discharge 80 m. c. ft. of water out of the 309 49 m. c. ft. stored between R. L. 202 (full supply) and R. L. 190 (sill level). While it is doing this, Sluice No. 1 is also discharging the remaining 229·49 m. c ft. at the rate of 48·3 c. ft per second for 1 month, with a 12-hours' flow, and at 29 c. ft. per second of continuous flow afterwards. Sluice No 2.

Supposing Sluice No. 2 has to discharge its share of 50 m. c. ft. in 3 months, during this period Sluice No. 1 will discharge—

	m c.ft.	Rate of discharge
1st month	... 62·41	... 48·3 cusecs per 12 hours daily.
2nd „	... 75·17	... 29 cusecs continuous.
3rd „	... 75·17	... do.
	212·75	

leaving 96·74 m. c. ft. for Sluice No. 2; a safe margin.

In the first 30 days Sluice No. 2 has to give a watering of 6", with a 12 hours' flow, to the 800 acres available for irrigation, and will have to discharge $\frac{800 \times 43{,}560 \times \frac{1}{2}}{1{,}296{,}000} = 13{\cdot}4$ c. ft per second.

At this speed it will dispose of 17·36 m. c. ft. in the first month, leaving 62·64 m. c. ft. to be discharged in 2 months of continuous flow, or at the rate of 12 c. ft. per second.

A $1\frac{3}{4}$ ft. diameter Sluice will discharge 14·8 m. c. ft. per sec., with 1 ft. head, and has been provided.

Design for Sluices.

13. The Sluices are similar in design (see Plans Nos. V & VI). Inlet channels varying in length and size have to be cut to each through the ridge on the front of the Dam; and an outlet channel for Sluice No. 2 at the rear of the Dam, for nearly a mile in length before the surface is reached and the channel can irrigate directly. Sluice No. 1 discharges into a small Nullah which leads into the river, and the water will flow down the bed of the river itself till the Namano Weir is reached 3 miles below; and just above this Weir, Irrigation Channel No. 1 will take off on the left bank of the river.

There are two masonry Sluice Chambers, the Sluices being fixed in the wall dividing the two.

The face wall of the outer chamber has a 3 ft. opening for its whole height, with double grooves $1\frac{1}{2}$ ft. apart into which planks can be put, with earth between, to shut off the water at any time when it is necessary to examine and repair the Sluice.

An iron grating with vertical bars is also provided in the face wall of the outer chamber to prevent brushwood, &c., passing into the Sluice Well.

The Sluices will be of cast-iron, with gun-metal faces, each fitted with two valves, one outside the Sluice Well and the other inside, so that if one valve gets out of order the one at the other end can be closed at once, and opened after the necessary repairs have been carried out.

These valves will be opened by vertical rods with screwed heads, and the screw wheel at the top should show clearly how much the valve is open at any time.

A wooden platform on iron rails is also provided from which to work the sluices.

A masonry drain runs from the sluice well under the rear slope of the Dam connected with the outlet channel; and Wing Walls with steps have been provided both in front and rear.

Irrigation Channel No 1

14. Irrigation Channel No. 1 will have a fall of 2 ft. per mile, and to discharge 48·3 c. ft. per second will have a bed width of 5 ft., depth of $3\frac{1}{2}$ ft., and side slope 1 to 1.

In the Estimate 6 miles length of this channel has been provided. This alllows for 5 miles after its junction with Channel No. 2, and it is assumed that $\frac{3}{4}$ s. miles of land will be irrigated for each mile length of Canal. Four Road Crossings have been provided in the Estimate.

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The Channel starts just above the Namano Weir, and to regulate the flow two Sluices are provided 1½ ft. in diameter at the head of the channel (see Plan No. VII.)

With the 5 ft. effective head available these can discharge 48·6 c. ft. per second, the maximum amount required.

Irrigation Channel No 2.

15. Irrigation Channel No. 2 has to discharge 14·3 c. ft. per second, and has a fall of 3 ft. per mile, bed with 3 ft., depth 2¼ ft. and side slopes 1 to 1. It will be 3 miles in length, and joins Irrigation Channel No. 1 just below Baora-khera village, and about 1 mile west of Namano.

The bed level of the Channels at their junction is R. L. 172 and 3 falls of 2 ft. each will be required in Channel No. 2 to obtain this bed level.

Raising and strengthening Namano Weir.

16. The present level of crest of the Namano Weir is R. L. 173. It is proposed to raise and strengthen this, bringing the crest to R. L. 177, and on this piers will be erected 3 ft. in height and 4 ft. apart, with grooves, into which shutters can be fixed to hold up the water, after the floods have passed, to R. L. 180 (see Plan No. VII). Irrigation Channel No. 1 starts with bed level R. L. 174.

As the overflow from the proposed Storage Reservoir at Haripura will find its way back into the river above Namano, we must be prepared for the maximum flood of 32,670 c. ft. per second on the 135 square miles of catchment to pass over the Namano Weir.

This Weir is 448 r. ft. in length, and will therefore be able to discharge this maximum flood with an 8 ft. head, or the flood water will rise to R. L. 185 when the shutters are open.

The left bank of the river on which Namano village stands is a good deal higher than this, and on the right bank there is rocky waste land, so that no damage will be done should the flood spill over on this side.

Guide Dam at Garerda

17. Where the Nullahs divide at Garerda and Loicha (see Index Map No. 1) it is proposed to construct Guide Dams to divert a portion of the water to Haripura.

The Nullah at Garerda has a catchment area of 86 square miles, giving a maximum discharge (by Dicken's Formula) of 23,290 c. ft. per second.

As approximately ¼ the natural flood passes into the Sukli Nullah and ¾ down to the Ghora Pichar we may assume that the Weir will have to discharge ¼ the flood water, or 5,823 c. ft. per sec., and to do this with 3 ft. depth of discharge it must be 318 r. ft. in length.

The Weir will be of masonry having a total length of 920 r. ft. (see Plan No. VIII.)

Taking R. L. 100 as bed of Nullah, the crest of Weir is R. L. 107, which, as pointed out by villagers, and from marks on rocks, is the height to which apparently floods rise.

For 556 ft. in the centre, ninety-three openings are provided, each $\frac{B}{4} \times \frac{H}{3}$ with sill R. L. 104, or 3 ft. below crest, making a total length of 372 r. ft. through which the flood can pass, and by means of the shutters the distribution of the water can also be regulated.

Dam at Loicha.

18. At Loicha the Dam has to divert the water of an extra $9\frac{1}{2}$ square miles, and to prevent the water already diverted at Garerda from passing out of the Haripura catchment.

The main Nullah here flows along rocky ground direct towards Haripura, and it is only in heavy floods that a portion spills over the left bank and passes out by a number of small Nullahs at a higher level into the Sukli catchment.

It is proposed to construct a masonry Guide Dam, 3 ft. thick at top and parallel to and on the left bank, averaging 3 ft. in height, to prevent this flood water passing out of the catchment (see Plan No. VIII).

Materials.

19. (*a*) Building stone is procurable near Namano, a distance of 2 miles.

(*b*) Limestone for lime is also procurable near Namano.

(*c*) Wood for fuel is procurable at site.

General Abstract of cost.

20. General Abstract of cost—

	Rs.
Main Dam...	73,755
Weir	21,166
Outlet Sluice No. 1	11,200
Outlet Sluice No. 2	5,057
Irrigation Channel No. 1	6,613
Irrigation Channel No. 2	1,530
Alterations to Namano Weir	9,111
Guide Dam at Garerda	6,461
Guide Dam at Loicha	13,974
Compensation	20,000
Contingencies	8,443
Total ...	1,77,310

Value of water stored

21. The value of water stored is 2,315 c. ft. per rupee.

Revenue

22. If all the 3,200 acres for which there is water available are irrigated, allowing Rs. 5 per acre, an annual revenue of Rs. 16,000 should be realized, or just under 9% profit on estimated cost.

If calculated at Rs. 3-4 per acre the difference of assessment between irrigated and unirrigated cultivated land in the Bundi State, an annual Revenue of Rs. 10,400 would be realized, or over $5\frac{3}{4}$% profit.

This does not take into account the bed of the Storage Reservoir, a large area of which could be cultivated as the water receded.

23. The Surveys and Plans have been prepared by Sub-Overseer Gunna Lal, under the direction and supervision of the Superintending Engineer, Protective Irrigation Works, Rajputana. Preparation of Project

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SPECIFICATION.

24. All the dimensions of the work are given in the Plans and Estimate, which are to be strictly adhered to. Dimensions

25. The centre line and side slopes to be marked out with trenches 1 ft broad and 1 ft. deep, showing permanently the inner and outer slopes and breadth of the top of the embankment. Marking Out.

26. The embankment will be carried out in layers not exceding 9" in thickness, carefully consolidated. All the layers will be laid concave, that is lower in the centre. Earth-work.

No clods of earth should on any account be allowed in the embankment No earth to be excavated within 200 ft. on either toe of the slopes.

27. The masonry of core-wall, weirs, outlet, sluices, &c, to be of rubble stone set in lime mortar; only hard and durable stones to be used, and the masonry to be kept wet during construction. All the stone to be hammer-dressed, and to break joint on the same as well as in the successive courses. Masonry

All stones to be laid on their natural beds; where there is batter the beds of the stones are to be at right angles to the batter. Hollows between the larger stones to be filled in with smaller ones completely embedded in mortar.

No empty hollow to be left, nor spaces filled wholly with mortar or rubbish where pieces of stone ought to have been inserted.

The faces of the masonry in contact with earth to be left quite rough, and those remaining exposed to be smoothed and pointed with lime mortar.

28. Mortar to consist of 1 part lime to 1½ parts surkee, the lime to be of limestone burnt in kilns. Lime Mortar

F. St-G. MANNERS SMITH,
SUPERINTENDING ENGINEER,
Protective Irrigation Works, Rajputana.

AJMER:
Dated 27th November 1904

ABSTRACT ESTIMATE OF COST.

Haripura Project on the Ghora-Pichar Nullah, Bundi State,

Quantity or No.	Item.	Rate.	Per.	Amount.	Total
	EARTHEN DAM.	Rs. A.		Rs.	Rs
4,763,650 c.ft.	Excavation for Water-way to Weir to be used in Embankment, ch. 1,660-6,000 ...	7—0	1,000 c.ft.	33,345	
2,799,625 „	Embankment, ch. 6,000-14,650.	5—0	1,000 „	13,998	
291,590 „	Pitching	3—0	100 „	8,748	
145,795 „	Kunkar	1—8	100 „	2,187	
					58,278
	CORE-WALL.				
67,634 „	Excavation	15—0	1,000 „	1,014	
34,631 „	Concrete	10—0	100 „	3,463	
61,115 „	Masonry	18—0	100 „	11,000	
					15,477
	WEIR.				
83,835 „	Rock cutting	2—0	100 „	1,678	
108,265 „	Masonry	18—0	100 „	19,488	
					21,166
	SLUICE No. 1.				
487,625 „	Excavation of Inlet and Outlet channels	6—0	1,000 „	2,926	
48,110 „	Excavation of Sluice chamber,	8—0	1,000 „	385	
13,505 „	Concrete	10—0	100 „	1,351	
21,894 „	Masonry	18—0	100 „	3,941	
945 „	Arch masonry	24—0	100 „	227	
671 „	Stone work	0—8	100 „	336	
23,000 „	Pitching	3—0	100 „	690	
2 No.	Sluice 1¾′ diameter	450—0	each.	900	
122 s ft.	Iron Grating	1—0	s.ft.	122	
56 c ft.	Woodwork	3—0	c.ft.	168	
78 r ft.	Iron Rails	1—0	r ft.	78	
308 „	Round Iron Rail 1″ diameter...	0—4	r ft.	76	
					11,200
	SLUICE No. 2.				
259,000 „	Excavation of Inlet and Outlet channels	6—0	1,000 c.ft.	1,554	
18,789 „	Excavation	8—0	1,000 „	150	
6,724 „	Concrete	10—0	100 „	672	
8,888 „	Masonry	18—0	100 „	1,599	
388 „	Arch masonry	24—0	100 „	94	
414 „	Stone work	0—8	...	207	
3,600 „	Pitching	3—0	100 „	108	
1 No.	Sluice 1¾′ diameter	450—0	each.	450	
60 s ft	Iron Grating	1—0	s.ft.	60	
25 c ft.	Woodwork	3—0	c.ft.	75	
40 r.ft.	Iron Rail	1—0	r.ft	40	
193 „	Round Rod Iron	0 4	r.ft.	48	
					5,057
	Carried over ...	...	...	...	1,11,178

Quantity or No.	Item.	Rate.	Per.	Amount.	Total.
		Rs. a.		Rs.	Rs.
	Brought over ...	...	...	...	1,11,178
	Guide Dam near Garerda.				
27,603 c.ft.	Excavation	15—0	1,000 c ft.	414	
27,132 ,,	Masonry	18—0	100 ,,	4,884	
651 ,,	Cut stone	0—8	c.ft.	326	
279 ,,	Wooden shutters	3—0	c.ft.	837	
					6,461
	Guide Dam near Loicha.				
48,911 c ft.	Excavation	15—0	1,000 c.ft.	734	
73,555 ,,	Masonry	18—0	100 ,,	13,240	
					13,974
	Raising and Altering Namano Weir.				
31,412 ,,	Excavation	15—0	1,000 c.ft.	471	
3,200 ,,	Concrete	10—0	100 ,,	320	
35,811 ,,	Masonry	18—0	100 ,,	6,445	
1,050 ,,	Cut stone	0—8	c. ft.	525	
450 ,,	Wooden shutters	3—0	,,	1,350	
					9,111
	Irrigation Channel No. 1.				
8,92,500 ,,	Excavation	4—0	1,000 c ft.	3,570	
4 No.	Road crossings	300—0	each	1,200	
					4,770
	Head Works.				
140 ,,	Excavation	15—0	1,000 c.ft.	107	
1,428 ,,	Concrete	10—0	100 ,,	143	
3,389 ,,	Masonry	18—0	100 ,,	610	
2 No.	Sluice 1½ ft. diameter ...	400—0	each	800	
26 c.ft	Woodwork	3—0	c. ft.	78	
105 s.ft.	Iron Grating	1—0	s. ft.	105	
					1,843
	Irrigation Channel No. 2.				
120,000 c.ft.	Excavation	4—0	1,000 c.ft.	480	
3 No.	Road crossings	300—0	each	900	
3 No.	Falls 2 ft. depth	50—0	each	150	
					1,530
	Compensation.				
2 No.	Retia and Dholpur villages ...	2,500—0	each	5,000	
1000.	Bighas land	15—0	bigha.	15,000	
					20,000
	Contingencies	5 —0	cent.	...	8,143
	Grand Total ..	...	...	...	1,77,310